Activity 4

Towards Climate-Smart, Resilient Wheat

Lead Researcher
Curtis Pozniak, professor and director of the Crop Development Centre in the Department of Plant Sciences at the University of Saskatchewan

KEY TAKEAWAYS

- **Research is working to develop new wheat varieties that are adapted to climate change**
- **This research is focused on three objectives:**
  - Improving nitrogen (N) use efficiency and reducing greenhouse gas emissions
  - Decreasing yield loss because of heat and drought stress
  - Better disease resistance under a changed and changing climate
- **The 2024 growing season was a good environment to test heat stress tolerance**
  - There were record high temperatures during wheat flowering, which is when it is most sensitive to high temperature
- **Disease nurseries are set up and functional**
  - Wheat breeding material tested is being infected with FHB and BLS, and then evaluated for their disease tolerance

This research activity, co-led by Curtis Pozniak and Kate Congreves of the Crop Development Centre and Department of Plant Sciences at the University of Saskatchewan (U of S) in Saskatoon, SK., aims to develop new wheat varieties that are adapted to a changing climate.

Climate change poses a great risk to stable wheat production. Recently, record high temperatures have been recorded across Western Canada, particularly during when the wheat is flowering, which is when it is most sensitive to high temperature. These trend extremes are likely to continue, presenting major challenges for farmers to produce stable wheat yields, manage nutrients and diseases, and maintain high wheat quality that we are known for.

Changes to the environment are putting greater pressure on the Canadian wheat sector in direct and indirect ways. Directly, climate change has brought on new challenges for wheat production through extreme temperature and variable precipitation patterns, and by further complicating existing agronomic challenges such as nutrient and pest management. A multidimensional approach is needed to develop climate-smart, resilient wheat. To this end, the research team believes the best approach is one that prioritizes both ecological and economic values, and one that embraces technological innovations, plant breeding, and agronomic management.

This research will pave the way for knowledge to develop new varieties of wheat that are better able to use nitrogen fertilizer, can withstand the effects of heat and drought, and that resist two devastating diseases of wheat. Knowledge gained from the research will be utilized by wheat breeding programs to improve selection efficiency, and to guide development of new and improved varieties that will benefit producers.

The research team's goal is to support the Canadian wheat sector by developing climate-smart, resilient wheat. Their research is focused on three objectives: 1) improving nitrogen (N) use efficiency and reducing greenhouse gas emissions; 2) decreasing yield loss due to heat and drought stress; 3) better disease resistance under a variable climate. Kate Congreves, is focusing on achieving objective one. Randy Kutcher, a wheat pathologist in the U of S Crop Development Centre, is leading objective three.

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The first objective of this research focuses reducing greenhouse gas emissions from fertilizer use in agriculture. Most of these emissions are nitrous oxide (N_2O), a potent greenhouse gas that has a warming potential 273 times greater than carbon dioxide (CO_2). For wheat production, this means that farmers may be faced with pressure to reduce N fertilizer use, however reducing N fertilizer rates or application frequency without improving crop N use efficiency will certainly result in lower yield and a considerable loss of revenue. As such, this research activity aims to find new ways to improve crop N use efficiency so farmers can effectively reduce N fertilizer rates without decreasing yield and ultimately revenue.

Producers have a long and successful record of adapting to the impacts of climate variability, but climate change will continue to represent an enormous challenge to crop production. Heat and drought stress has and will continue to reduce crop productivity and current climate change models suggest an increasing occurrence and severity of both. Tolerance to heat and water stress is a central characteristic of yield stability and its continued improvement is an important target for wheat breeders. In the second objective of this research the investigators will use different approaches to identify the genetic factors in their wheat breeding material that are critical to heat stress tolerance in Western Canadian wheat and to evaluate the potential of increasing wheat biomass to serve as an energy reserve during periods of high temperature and terminal drought stress.

The third objective of this research prioritizes increasing disease tolerance. The pathogens that cause disease are also evolving to a changing climate. Continued use of fungicidal crop protection products to reduce yield loss due to disease is not sustainable and costs farmers a great amount of resources and time. Of the multiple wheat diseases of concern, Fusarium head blight (FHB) is the most common in Western Canada and its presence has increased by warmer nighttime temperatures. The level of resistance in most wheat classes is insufficient during a year with high risk to FHB. Another disease that is of increasing concern is bacterial leaf streak (BLS), which has been reported by farmers even under dry conditions. Currently little is known about the extent of genetic variation in wheat we can use to increase tolerance to these diseases. The research in this objective addresses this.

The 2024 field trials had excellent conditions to evaluate heat and drought stress as this season had high daytime temperatures during flowering, when wheat is most sensitive to heat. Further to this, N use efficiency data were collected, including N_2O measurements, by Congreves in field trials close to Saskatoon. Disease nurseries near Aberdeen, SK. were set-up and were successful and ensuring the wheat breeding material tested was infected with FHB and BLS, which were then evaluated for their tolerance to these diseases. Currently the researchers are analyzing the data collected in all field experiments and grain quality measurements are well underway in the Grains Innovation Laboratory at the Crop Development Centre.